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Thelander et al.

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(54) **REDUNDANT FULL COLOR PAGEWIDE PRINTHEAD HAVING NARROW PRINT ZONE**

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(73) Assignee: **Memjet Technology Limited**

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(22) Filed: **Sep. 10, 2020**

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Related U.S. Application Data

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(51) **Int. Cl.**

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B41J 2/175	(2006.01)
B41J 2/155	(2006.01)
B41J 2/145	(2006.01)
B41J 2/21	(2006.01)
B41J 2/17	(2006.01)

(52) **U.S. Cl.**

CPC ***B41J 2/145*** (2013.01); ***B41J 2/14*** (2013.01); ***B41J 2/1433*** (2013.01); ***B41J 2/14209*** (2013.01); ***B41J 2/155*** (2013.01); ***B41J 2/17*** (2013.01); ***B41J 2/175*** (2013.01); ***B41J 2/2103*** (2013.01); *B41J 2002/14491* (2013.01); *B41J 2202/13* (2013.01); *B41J 2202/20* (2013.01)

(58) **Field of Classification Search**

CPC . B41J 2/145; B41J 2/14; B41J 2/14209; B41J 2/1433; B41J 2/155; B41J 2/17; B41J 2/175; B41J 2202/20

See application file for complete search history.

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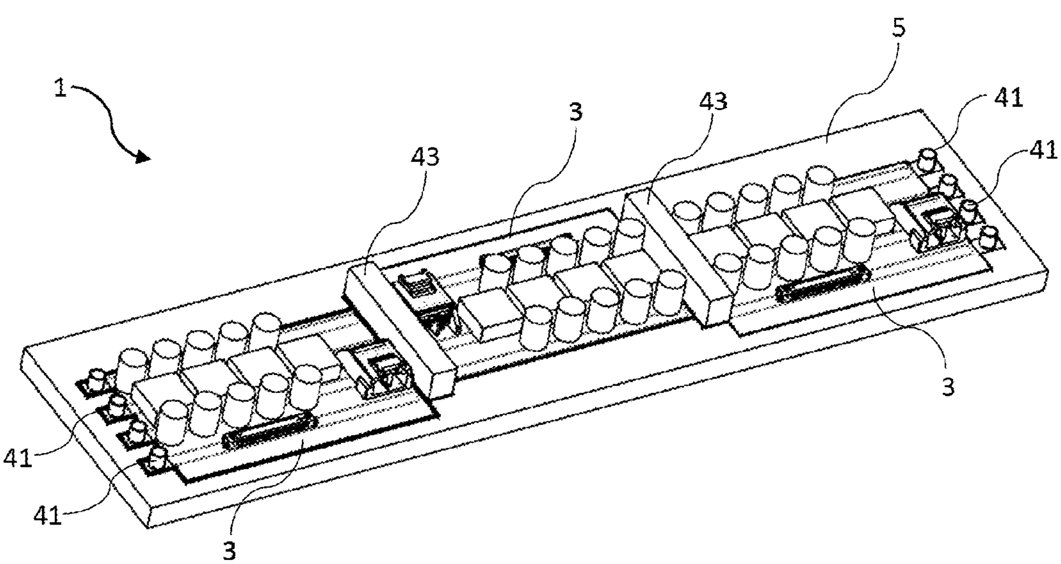
(57) **ABSTRACT**

A modular inkjet printhead includes a plurality of printhead modules arranged end on end in a row, each printhead module having at least four rows of print chips configured for printing at least four different inks, each print chip having multiple nozzle rows for redundant printing of a respective ink. A print zone of the printhead has a width of less than 100 mm in a media direction.

18 Claims, 9 Drawing Sheets



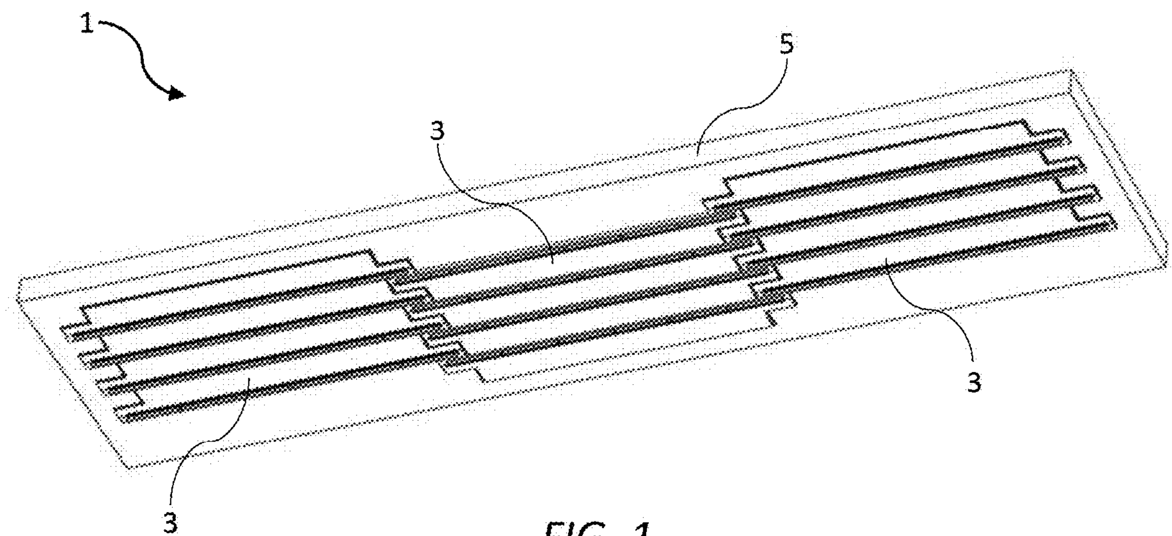
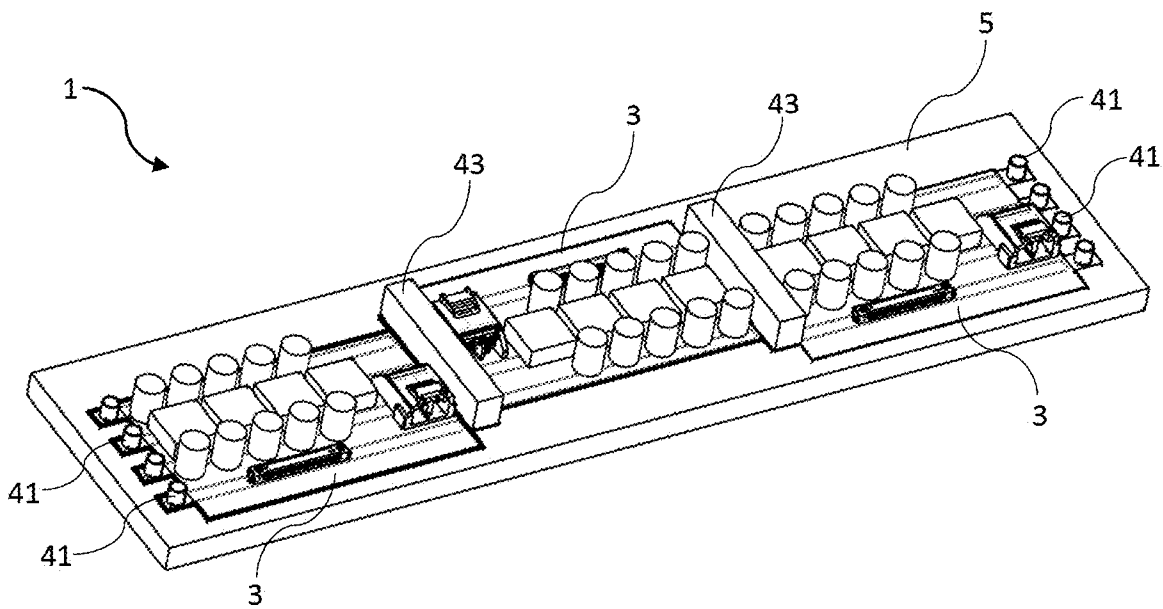


FIG. 1



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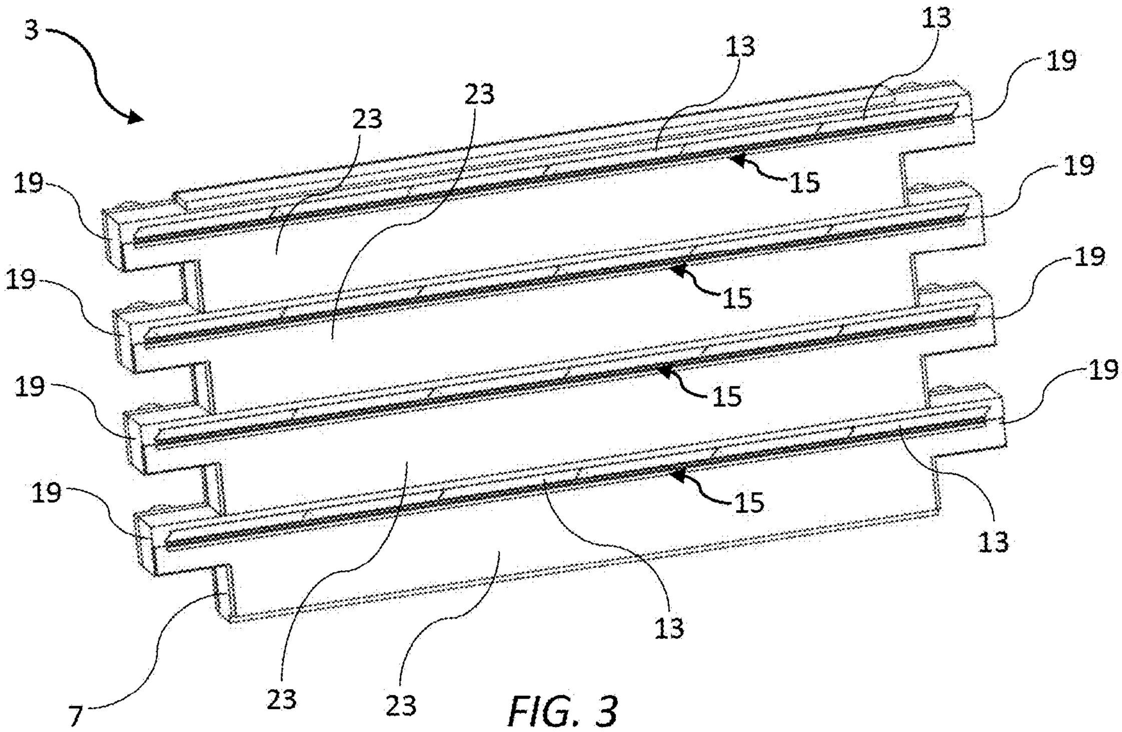
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FIG. 3

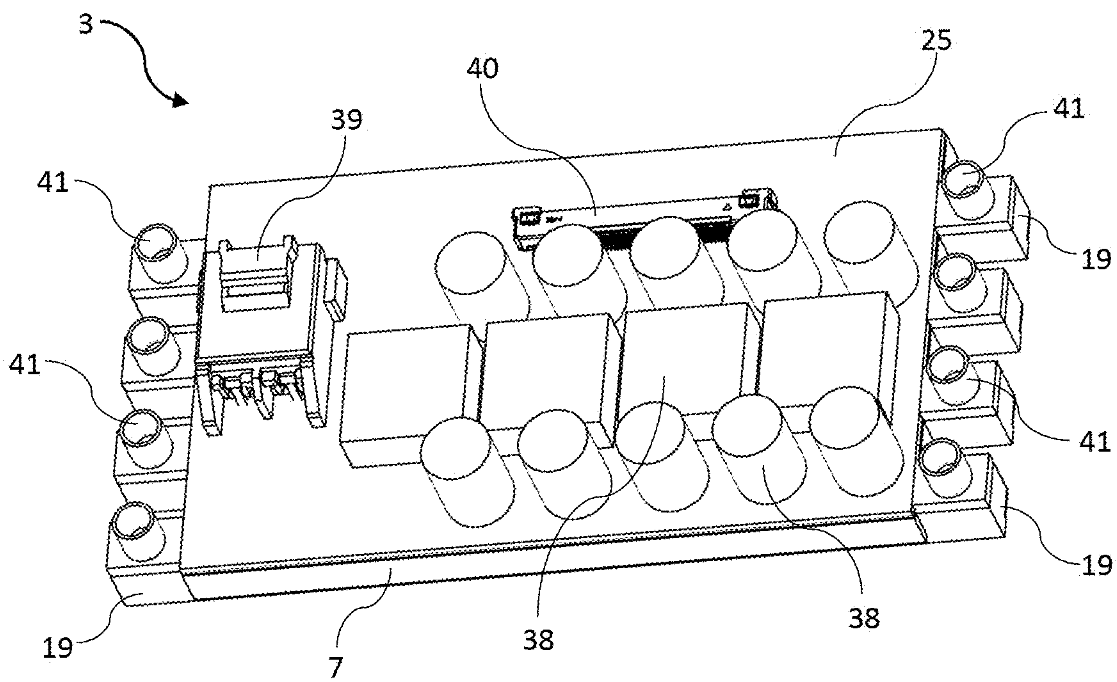
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FIG. 4

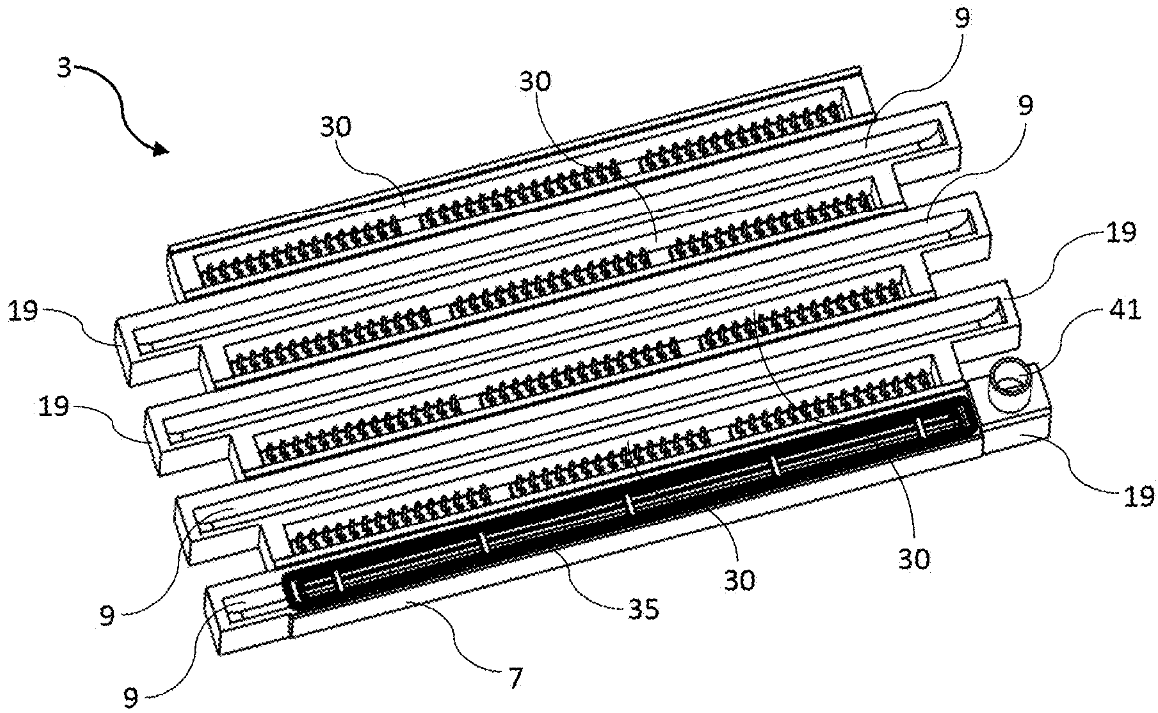
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FIG. 5

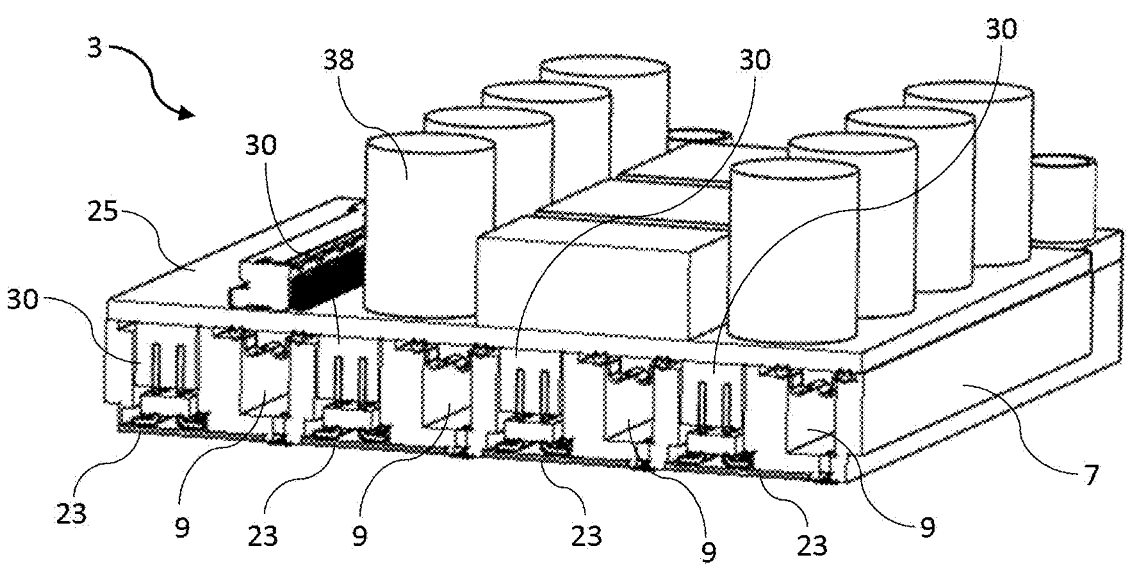
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FIG. 6

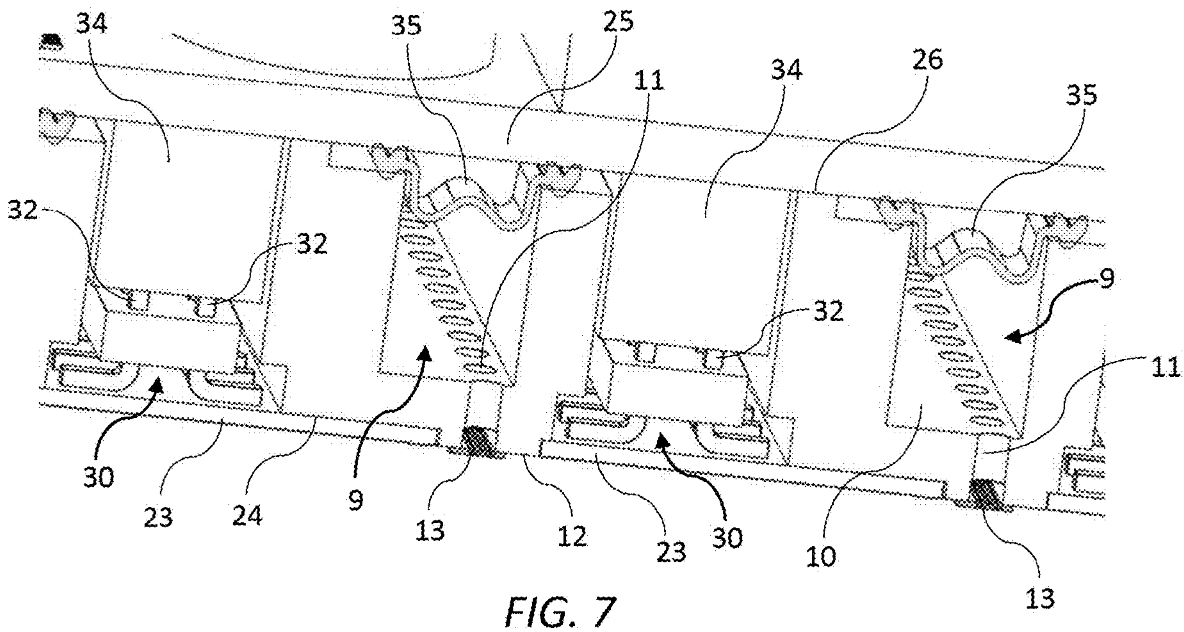


FIG. 7

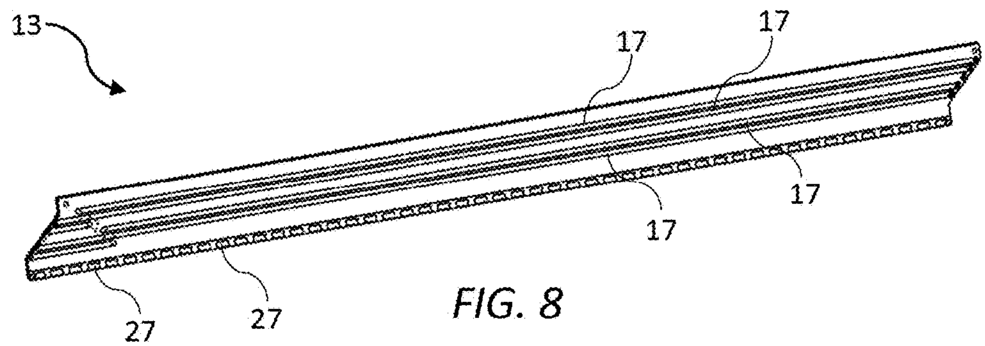
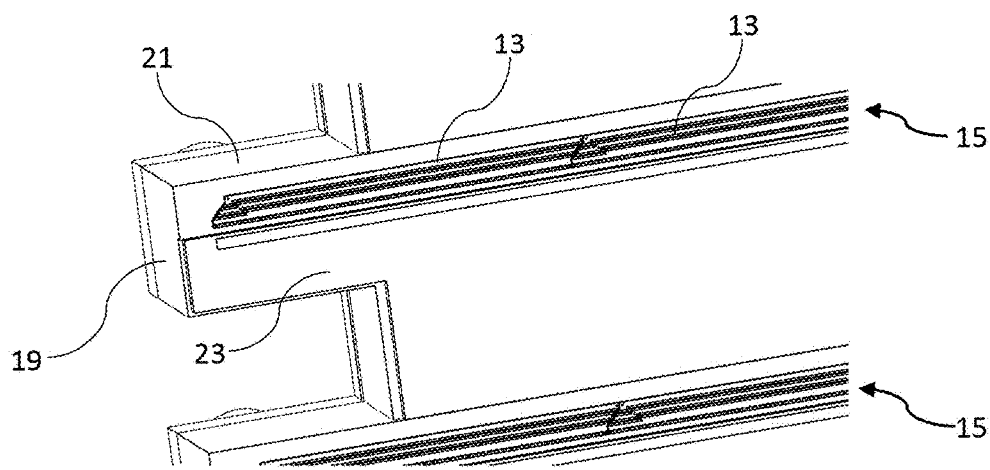


FIG. 8



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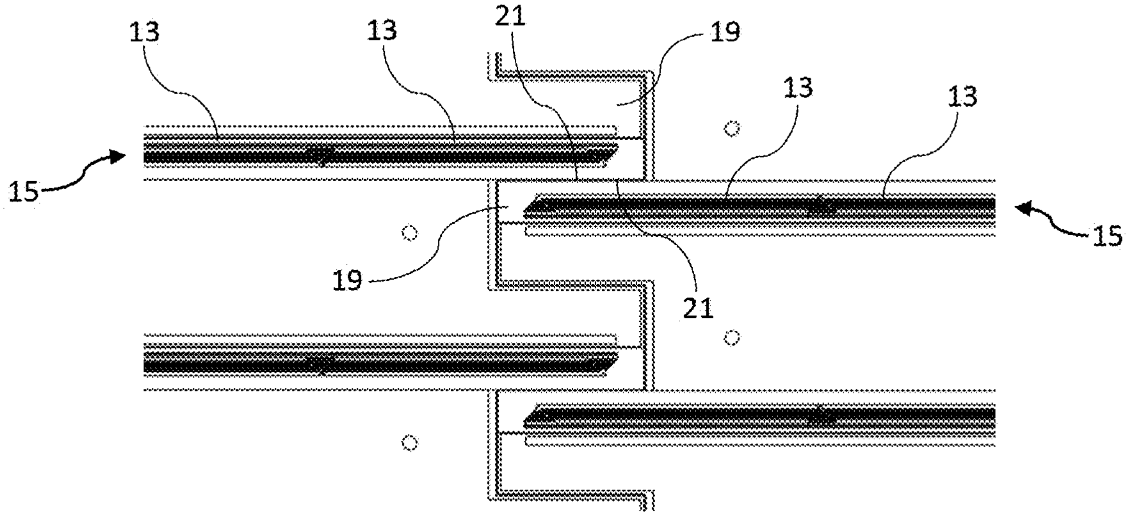

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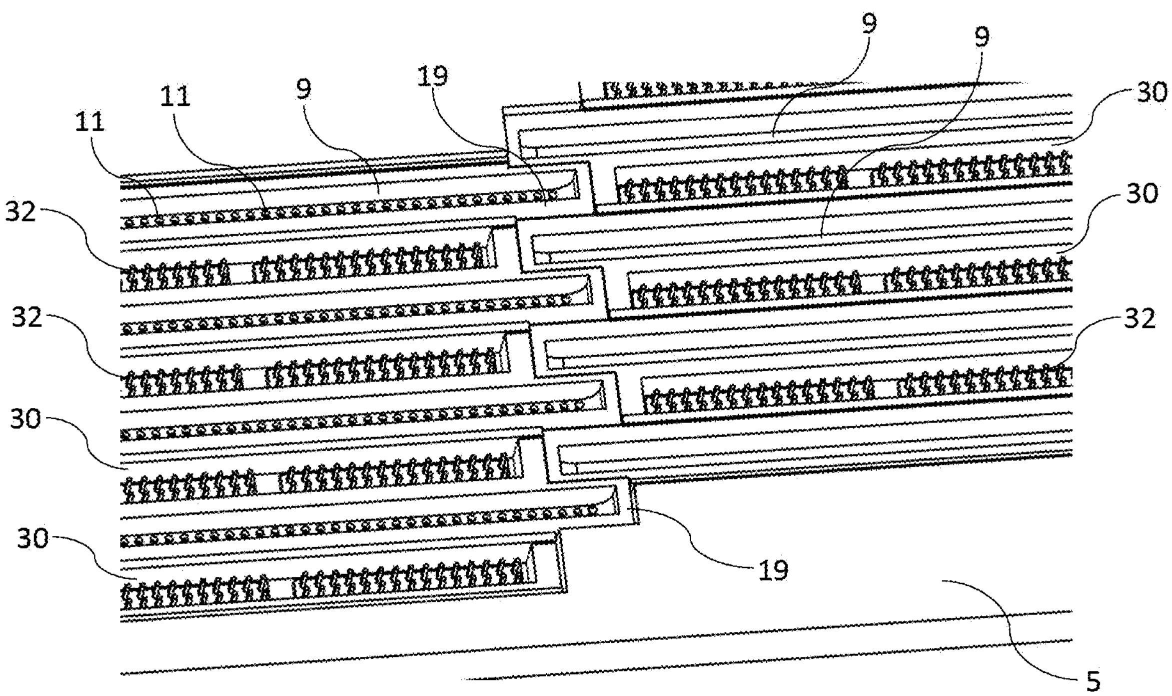

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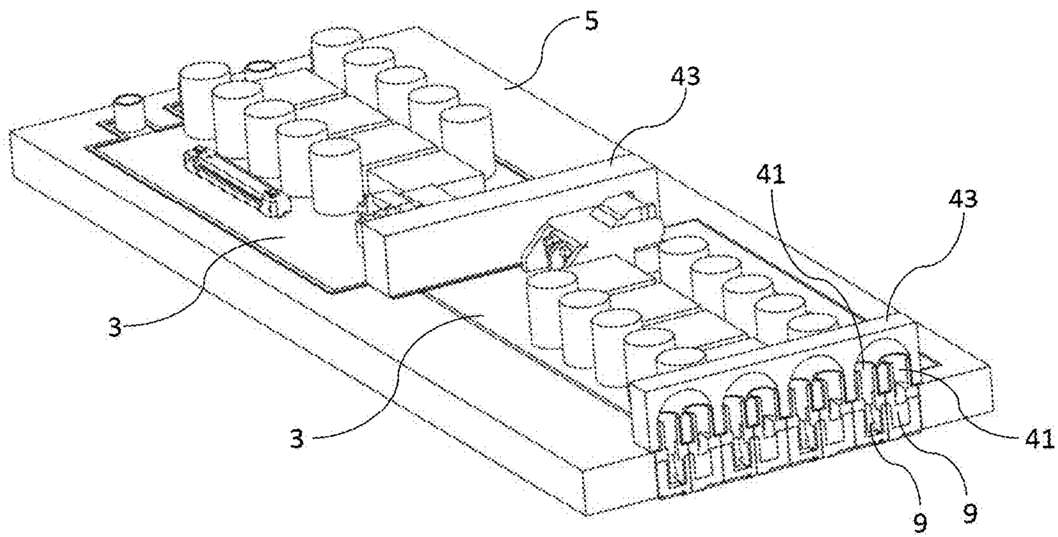
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FIG. 12

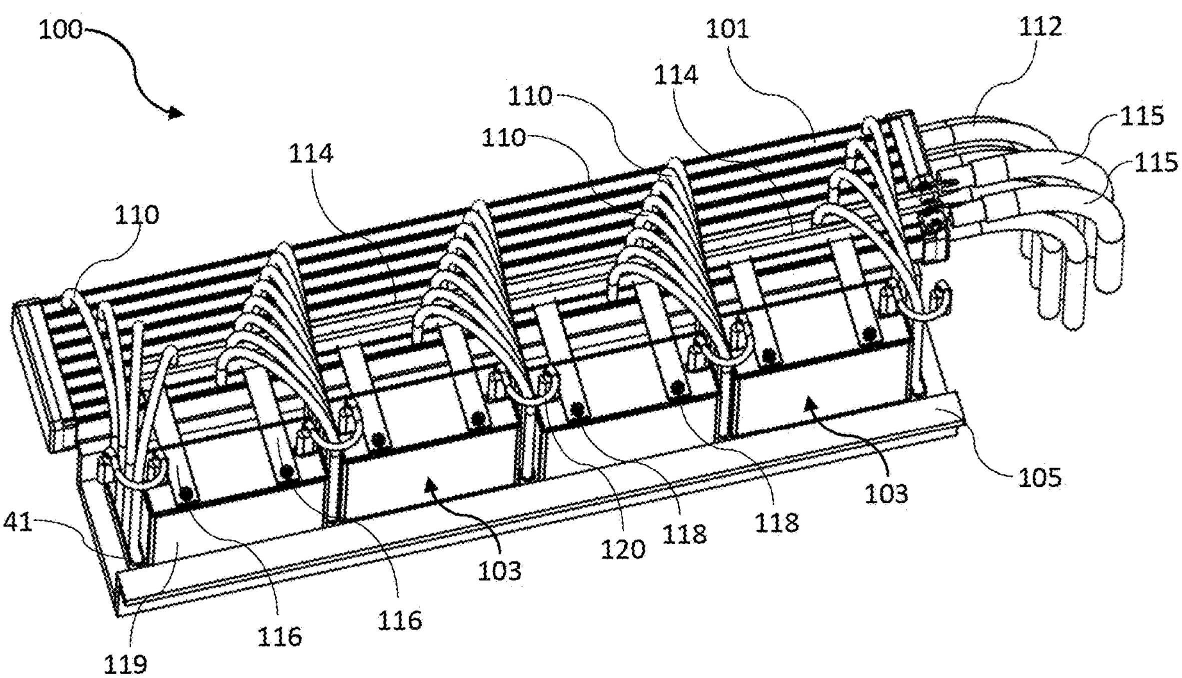
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FIG. 13

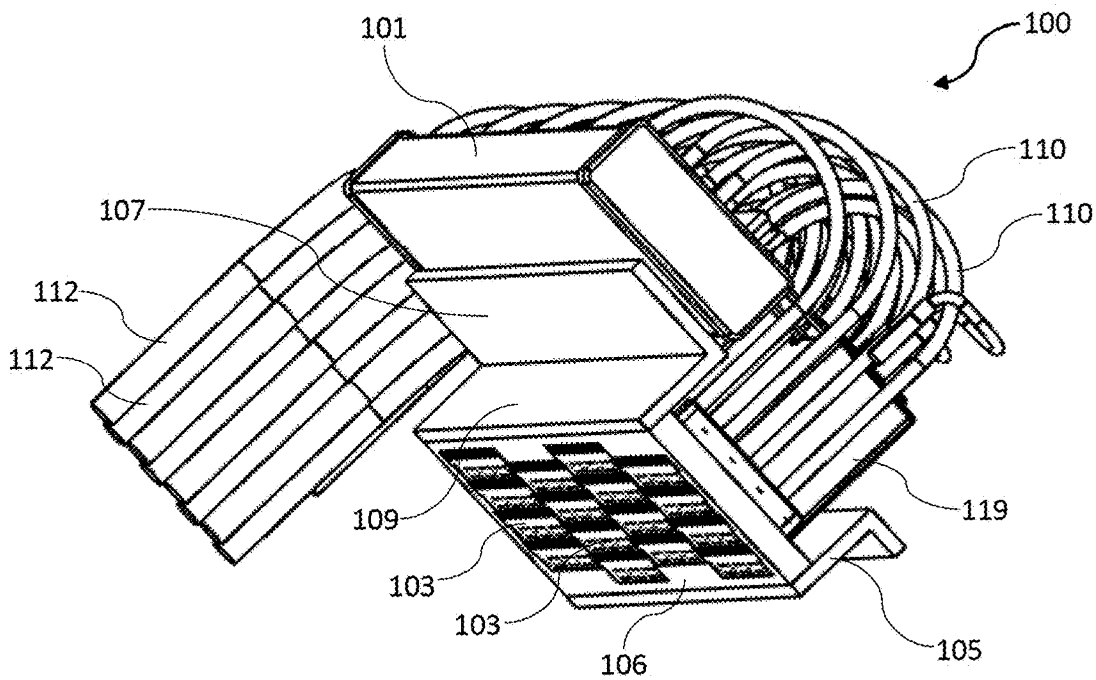
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FIG. 14

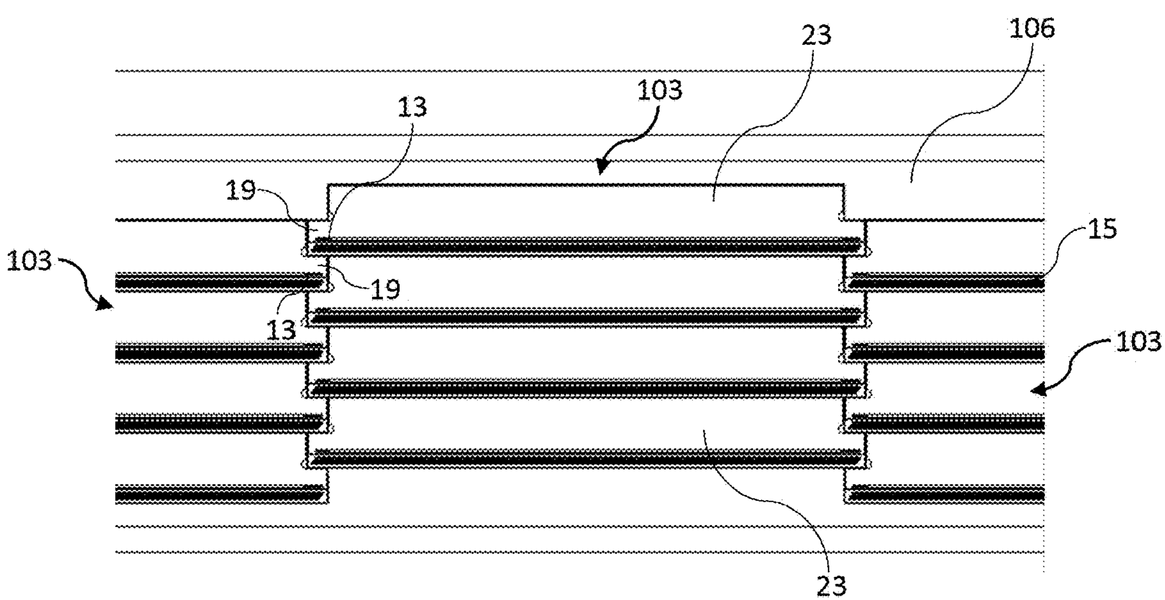
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FIG. 15

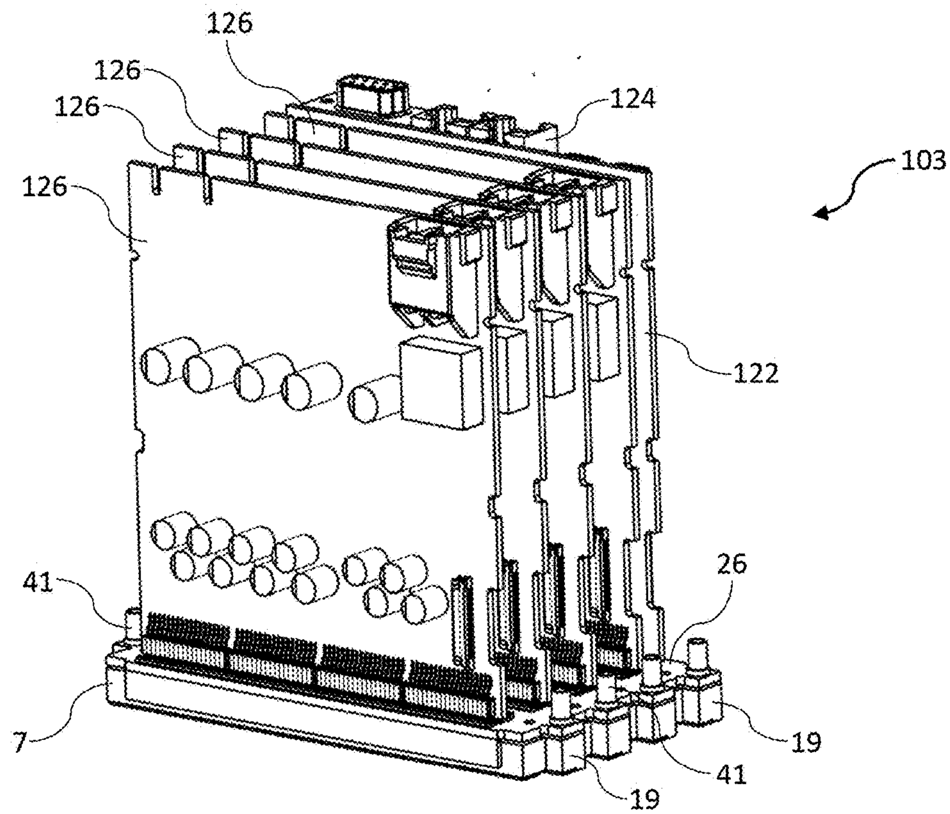
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FIG. 16

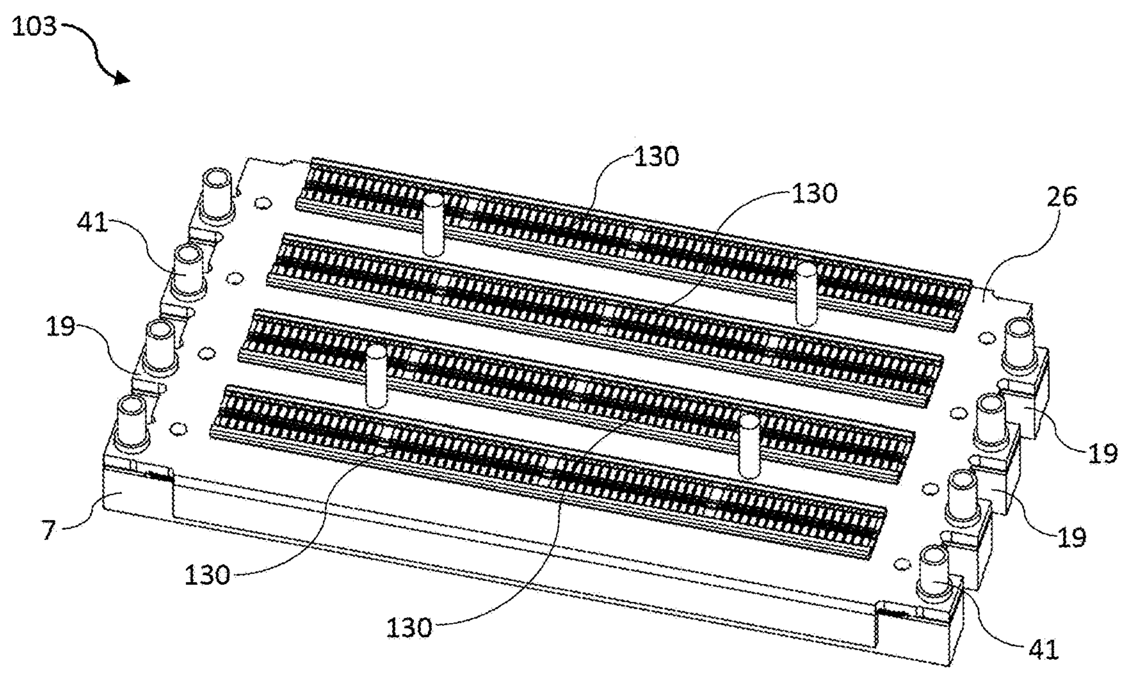
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FIG. 17

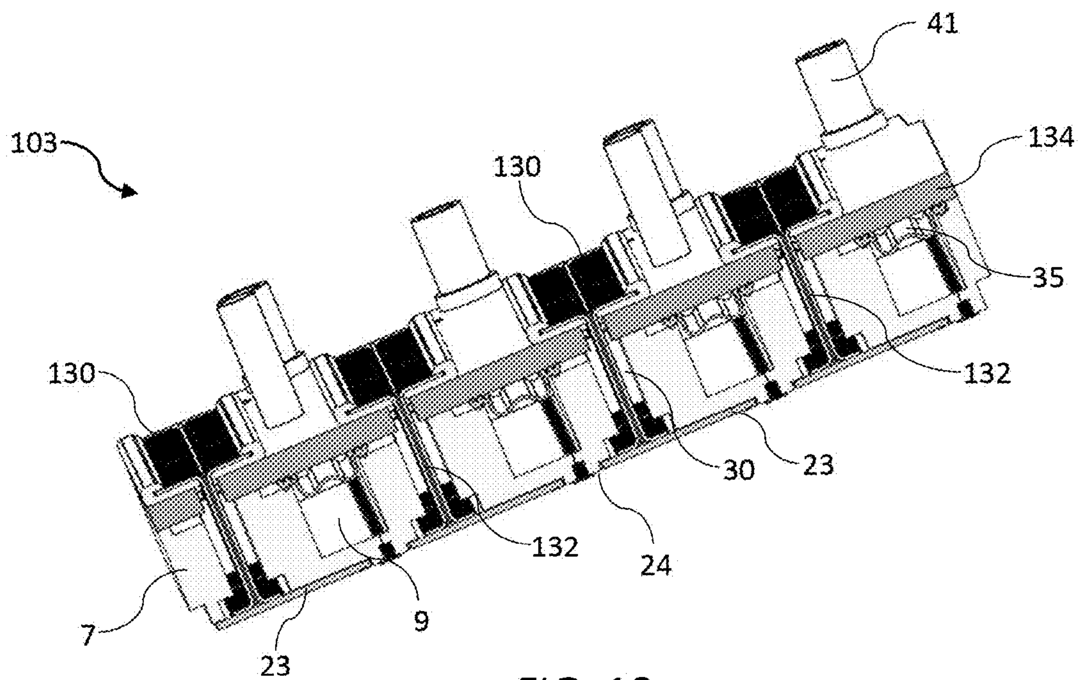

FIG. 18

REDUNDANT FULL COLOR PAGEWIDE PRINTHEAD HAVING NARROW PRINT ZONE

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of priority to U.S. Provisional Application No. 62/900,356 filed Sep. 13, 2019 and to U.S. Provisional Application No. 63/023,370 filed May 12, 2020, the contents of which are incorporated herein by reference for all purposes.

FIELD OF THE INVENTION

This invention relates to an inkjet printhead. It has been developed primarily to provide a robust, full-color modular printhead suitable for high quality pagewide printing.

BACKGROUND OF THE INVENTION

The Applicant has developed a range of Memjet® inkjet printers as described in, for example, WO2011/143700, WO2011/143699 and WO2009/089567, the contents of which are herein incorporated by reference. Memjet® printers employ one or more stationary inkjet printheads in combination with a feed mechanism which feeds print media past the printhead in a single pass. Memjet® printers therefore provide much higher printing speeds than conventional scanning inkjet printers.

Digital presses suitable for relatively short print runs represent a significant market opportunity for pagewide printing technology. Pagewide inkjet printing units may be used to replace traditional analogue printing plates in an offset press without significant modifications to expensive media feed systems. The present Applicant has developed printing systems suited to the needs of OEMs wishing to upgrade existing offset presses to high-speed digital inkjet presses. For example, U.S. Pat. No. 10,099,494 (incorporated herein by reference) describes a modular printing system comprising monochrome print bars having one or more print modules. Each print module has 5× redundancy by virtue of 5 nozzle rows in a respective printhead, providing high quality, high speed printing suited to the requirements of inkjet press OEMs. The modular printing system may be configured for full color printing by stacking monochrome print bars along a media feed path, as described in U.S. Pat. No. 10,099,494.

Notwithstanding these improvements in modular inkjet printing systems, there is still a need to improve such systems further. One disadvantage of using an array of monochrome print bars is that the overall print zone for full color printing is relative long. Even with innovative measures to minimize the inter-print bar separation, the print zone for four print bars (e.g. CMYK print bars) may still be 500 mm in length along the media feed path. Longer print zones create challenges, not only in terms of alignment and accurate dot-on-dot placement, but also integration into an existing offset media feed system. For example, limited space may be available for an inkjet print engine in the media feed path and reconfiguring media feed systems to accommodate such a print engine is costly for OEMs.

One approach to minimizing the size of the print zone to print four colors of ink from each printhead and stagger printheads across the print zone. One such printer is described in, for example, WO2011/011824. However, a problem with such printers is that each color channel has no

redundancy, which inevitably impacts on speed and/or print quality. Accordingly, printers of this type are not usually suitable for use in digital ink presses.

It would therefore be desirable to provide a modular printing system suitable for digital inkjet presses, which has a print zone of minimal length along the media feed direction. It would be particularly desirable to provide such a printing system having sufficient redundancy for high quality, high-speed printing. Efficient arrangements for supplying ink, power and data to multiple closely packed print chips would also be desirable.

SUMMARY OF THE INVENTION

In one aspect, there is provided a modular inkjet printhead comprising a plurality of printhead modules arranged end on end in a row, each printhead module comprising:

- a substrate having a plurality of parallel ink supply channels extending longitudinally along a length thereof;
- a plurality of parallel printhead segments extending longitudinally along a length of the substrate, each printhead segment comprising a plurality of print chips arranged end on end in a row, each print chip in one row receiving ink from a respective one of the ink supply channels, and each print chip comprising a plurality of nozzle rows configured for redundant printing,

wherein:

- a plurality of fingers extend longitudinally from opposite ends of each printhead module;
- each finger comprises a portion of a respective one of the printhead segments; and
- the fingers of neighboring printhead modules are interdigitated such that printhead segments of neighboring printhead modules overlap.

The printhead according to the first aspect advantageously enables multiple printhead segments to be positioned in an overlapping arrangement whilst minimizing a distance between overlapped segments in a media feed direction. Thus, the overall length of the print zone along the media feed direction is minimized whilst maintaining multiple redundancy in each color channel.

Preferably, all printhead modules are identical.

In one embodiment, each printhead module is oriented in a same direction with respect to a media feed direction. In another embodiment, alternate printhead modules are oriented in an opposite direction with respect to a media feed direction.

Preferably, the portion of each printhead segment contained in a respective finger is positioned towards one lateral edge of the finger.

Preferably, each printhead module comprises at least four printhead segments.

Preferably, wherein a print zone of the printhead is less than 100 mm.

Preferably, a number of fingers is twice a number of printhead segments.

Preferably, each substrate has opposite first and second faces, the first face having one or more first PCBs mounted thereon and the second face having one or more second PCBs mounted thereon.

Preferably, the first and second PCBs are generally perpendicular to each other.

Preferably, the first and second PCBs are connected via electrical connectors extending through longitudinal slots defined in the substrate.

Preferably, each pair of neighboring ink supply channels has one of said longitudinal slots positioned therebetween.

Preferably, each ink supply channel has a base defining a plurality of ink outlets and a roof comprising an elongate flexible film, and wherein each print chip receives ink from one or more of the ink outlets.

Preferably, each second PCB comprises one or more external connectors selected from the group consisting of: a power connector and a data connector.

Preferably, each ink supply channel has an ink port at opposite ends thereof, the ink port extending away from the substrate.

Preferably, corresponding adjacent ink ports of neighboring printhead modules are interconnected.

Preferably, the ink ports are connected to respective inlet and outlet channels of a common ink carrier extending a length of the printhead.

In a related aspect, there is provided a printhead module for a modular inkjet printhead having a plurality of said printhead modules, the printhead module comprising:

- a substrate having a plurality of parallel ink supply channels extending longitudinally along a length thereof;
- a plurality of parallel printhead segments extending longitudinally along a length of the substrate, each printhead segment comprising a plurality of print chips arranged end on end in a row, each print chip in one row receiving ink from a respective one of the ink supply channels, and each print chip comprising a plurality of nozzle rows configured for monochrome printing,

wherein:

- a plurality of fingers extend longitudinally from opposite ends of the printhead module;
- each finger comprises a portion of a respective one of the printhead segments; and
- each finger is configured such that fingers of neighboring printhead modules are interdigitated, thereby enabling printhead segments of neighboring printhead modules to overlap.

Preferably, each substrate has opposite first and second faces, the first face having one or more first PCBs mounted thereon and the second face having one or more second PCBs mounted thereon.

Preferably, the first and second PCBs are connected via electrical connectors extending through longitudinal slots defined in the substrate.

In a second aspect, there is provided a modular inkjet printhead comprising a plurality of printhead modules arranged end on end in a row, each printhead module having at least four rows of print chips configured for printing at least four different inks, each print chip having multiple nozzle rows for redundant printing of a respective ink, wherein a print zone of the printhead is less than 100 mm in a media feed direction.

The modular inkjet printhead according to the second aspect advantageously combines full color printing and multiple redundancy in each color in a modular printhead having a narrow print zone. Such printheads are highly suitable for low-cost integration into existing media feed pathways used in offset presses.

Preferably, each print chip has at least three nozzle rows configured for redundant printing.

Preferably, the printhead modules have at least four fingers corresponding to said at least four rows of print chips, the fingers of neighboring printhead modules being interdigitated.

Preferably, each finger comprises at least a portion of a respective print chip.

Preferably, neighboring printhead modules have overlapping print chips contained in respective fingers.

Preferably, each finger has its respective print chip positioned towards one lateral edge thereof.

In one embodiment, each alternate printhead module is oppositely oriented with respect to a media feed direction, thereby positioning overlapped print chips in relative proximity to each other. In another embodiment, each printhead module is oriented in a same direction with respect to a media feed direction.

Preferably, each print chip receives power and data through a respective longitudinal slot.

Preferably, the longitudinal slots are alternately arranged with longitudinal ink supply channels in each printhead module.

Preferably, each printhead module comprises a monolithic substrate having the longitudinal ink supply channels and longitudinal slots defined therein.

Preferably, the monolithic substrate is comprised of a material selected from: polymers, metal alloys and ceramics.

Preferably, each substrate has opposite first and second faces, the first face having one or more first PCBs mounted thereon and the second face having one or more second PCBs mounted thereon.

Preferably, the first and second PCBs are generally perpendicular to each other.

Preferably, the first and second PCBs are connected via electrical connectors extending through longitudinal slots defined in the substrate.

Preferably, a plurality of first PCBs co-mounted on the first face of each printhead module with the print chips, each row of print chips being electrically connected to a respective first PCB.

Preferably, each print chip is electrically connected to its respective first PCB via wirebonds.

In a third aspect, there is provided a modular inkjet printhead comprising a plurality of printhead modules arranged end on end in a row, each printhead module comprising:

- a substrate having a plurality of ink supply channels;
- a plurality of print chips mounted on the substrate, each print chip receiving ink from a respective ink supply channel;
- a plurality of fingers extending longitudinally from opposite ends of each printhead module, each finger comprising at least a portion of a respective print chip,

wherein:

- the fingers of neighboring printhead modules are interdigitated such that print chips of neighboring printhead modules overlap; and
- the portion of the print chip contained in a respective finger is positioned towards one lateral edge of the finger.

The modular printhead according to the third aspect advantageously minimizes a distance between overlapping print chips, thereby minimizing an overall width of the print zone.

Preferably, the lateral edges of neighboring printhead modules are proximal so as to minimize a distance between overlapping print chips.

Preferably, each printhead module has at least four rows of print chips.

Preferably, each print chip has multiple nozzle rows for redundant printing of a respective ink.

Preferably, the printhead modules have at least four fingers corresponding to at least four rows of print chips, the fingers of neighboring printhead modules being interdigitated.

Preferably, each finger comprises a portion of a respective ink supply channel, such that corresponding ink supply channels of neighboring printhead modules overlap.

Preferably, each finger comprises an ink port, such that ink ports of neighboring printhead modules overlap.

In a fourth aspect, there is provided a modular inkjet printhead comprising a plurality of printhead modules arranged end on end in a row, each printhead module comprising:

- a substrate having a plurality of longitudinal ink supply channels;
- a plurality of print chips mounted on a first face of the substrate, each print chip receiving ink from a respective ink supply channel;
- a plurality of fingers extending longitudinally from opposite ends of each printhead module, each finger having an ink port extending away from a second face of the substrate opposite the first face, each ink port being in fluid communication with a respective ink supply channel,

wherein:

- each ink supply channel is connected to a respective pair of ink ports at opposite ends of each printhead module;
- the fingers of neighboring printhead modules are interdigitated such that the ink ports of neighboring printhead modules overlap.

The printhead according to the fourth aspect advantageously enables an array of printhead modules to be nested together in a row whilst supplying ink to the whole array. A minimal distance between ink ports and ink supply channels of respective printhead modules maximizes flow rates through the printhead and minimizes pressure drops.

Preferably, the ink ports at a one end of each printhead module are ink inlet ports and ink ports at an opposite end of each printhead module are ink outlet ports.

Preferably, the longitudinal ink supply channels are alternately arranged with longitudinal slots defined through a thickness of the substrate.

Preferably, the longitudinal slots do not extend into the fingers of each printhead module.

Preferably, each longitudinal slot receives electrical connections for supplying data and power to the print chips.

Preferably, the ink supply channels within one printhead module are fluidically isolated from each other.

Preferably, the print chips are arranged in a plurality of rows, each row corresponding to a respective one of the ink supply channels.

Preferably, each finger contains at least part of one print chip.

Preferably, ink ports of neighboring printhead modules are aligned in a row extending transverse to a longitudinal axis of the printhead.

Preferably, wherein each printhead module comprises four ink supply channels corresponding to four ink colors, four rows of print chips corresponding to the four ink colors, and a pair of fingers corresponding to each of the four rows of print chips to provide eight fingers in total.

In a related aspect, there is provided a printhead module comprising:

- a substrate having a plurality of longitudinal ink supply channels;

- a plurality of print chips mounted on a first face of the substrate, each print chip receiving ink from a respective ink supply channel;
- a plurality of fingers extending longitudinally from opposite ends of each printhead module, each finger having an ink port extending away from an opposite second face of the substrate, each ink port being in fluid communication with a respective ink supply channel,

wherein:

- the fingers of neighboring printhead modules are configured to be interdigitated; and
- each ink supply channel is connected to a respective pair of ink ports at opposite ends of each printhead module.

As used herein, the term "ink" is taken to mean any printing fluid, which may be printed from an inkjet printhead. The ink may or may not contain a colorant. Accordingly, the term "ink" may include conventional dye-based and pigment-based inks, infrared inks, UV inks, fixatives (e.g. pre-coats and finishers), functional fluids (e.g. solar inks, sensing inks), 3D printing fluids, biological fluids and the like. Where reference is made to fluids or printing fluids, this is not intended to limit the meaning of "ink" herein.

As used herein, the term "mounted" includes both direct mounting and indirect mounting via an intervening part.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings, in which:

FIG. **1** is a front perspective of a modular inkjet printhead according to a first embodiment;

FIG. **2** is a rear perspective of the printhead shown in FIG. **1**;

FIG. **3** is a front perspective of an individual printhead module according to a first embodiment;

FIG. **4** is a rear perspective of the printhead module shown in FIG. **3**;

FIG. **5** is a rear perspective of the printhead according to the first embodiment with various components removed to reveal longitudinal ink supply channels;

FIG. **6** is a sectional perspective of the printhead module according to the first embodiment;

FIG. **7** is a magnified sectional perspective of the printhead module according to the first embodiment;

FIG. **8** is a perspective of an individual print chip;

FIG. **9** is a magnified perspective of a finger extending from one end of the printhead module according to the first embodiment;

FIG. **10** is a magnified plan view of a pair of interdigitated fingers according to the first embodiment;

FIG. **11** is a rear perspective of a pair of nested printhead modules according to the first embodiment;

FIG. **12** is a sectional perspective of the printhead according to the first embodiment showing a linking manifold;

FIG. **13** is a front perspective of a modular inkjet printhead according to a second embodiment;

FIG. **14** is a side perspective of the printhead shown in FIG. **13**;

FIG. **15** is a plan view of neighboring printhead modules according to the second embodiment;

FIG. **16** is a perspective of a printhead module according to the second embodiment with backside PCBs;

FIG. **17** is a perspective of the printhead module shown in FIG. **16** with backside PCBs removed; and

FIG. **18** is a sectional perspective of the printhead module shown in FIG. **17**.

DETAILED DESCRIPTION OF THE INVENTION

First Embodiment

Referring to FIGS. **1** and **2**, there is shown a modular inkjet printhead **1** (or "print bar") according to a first embodiment of the invention. The printhead **1** comprises a plurality of printhead modules **3** arranged end on end and mounted to a complementary support structure **5**. Typically, the support structure **5** has one or more openings configured for complementarily receiving the printhead modules **3**. Although three printhead modules **3** are shown in the embodiment of FIGS. **1** and **2**, it will be appreciated that the printhead **1** may contain a greater or fewer number of printhead modules (e.g. 1 to 20 printhead modules) in order to construct a pagewide print bar of any required length.

FIGS. **3** to **7** show an individual printhead module **3** according to the first embodiment. Each printhead module **3** comprises a substrate **7** in the form an elongate ink manifold having four parallel ink supply channels **9** extending longitudinally along a length thereof. The ink supply channels **9** are defined in a backside face of the substrate **7** and a plurality of ink outlets **11** are defined in a base of each ink supply channel The ink outlets **11** supply ink from a respective ink supply channel **9** to a plurality of print chips **13** mounted in a row along a respective frontside chip mounting surface **12** of the substrate **7**. The four rows of print chips **13** are aligned with the four rows of ink supply channels **9**, typically for printing CMYK inks. Each row of print chips **13** in one printhead module **3** defines a printhead segment **15** of the printhead, with each printhead segment containing six print chips butted end on end in a row. Print chips configured for butting end on end in a pagewide arrangement will be known to the person skilled in the art. For example, the Applicant's dropped nozzle triangle architecture for linking print chips in a row is described in U.S. Pat. No. 7,290,852, the contents of which are herein incorporated by reference.

Of course, the number of printhead segments **15** in each printhead module **3** may be fewer or greater than four, depending on the particular application. For example, a printhead module **3** may have up to ten printhead segments for printing additional spot colors (e.g. orange, violet, green, khaki etc), UV inks, IR inks and/or a fixative fluid. Likewise, each printhead segment **15** may contain fewer or greater than six print chips (e.g. 2 to 15 print chips).

As best shown in FIG. **7**, each print chip **13** is fed with ink from a respective one of the ink supply channels **9** and configured for monochrome printing. Each print chip **13** has a plurality of nozzle rows **17** (e.g. 2 to 10 nozzle rows) for redundant monochrome printing. In other words, a plurality of nozzles are available for printing each pixel position for a given ink, providing improved speed and/or print quality. FIG. **8** shows a print chip **13** in isolation have four nozzle rows **17** providing 4× redundancy. Memjet® print chips having five nozzle rows, providing 5× redundancy, are equally suitable for use in the printhead module **3**.

The printhead modules **3** therefore provide the significant advantage of multiple-redundant full-color printing across a relatively narrow print zone. Typically, the print zone of the printhead **1** has a dimension of less than 200 mm, less than 100 mm or less than 80 mm in a media feed direction—that is, transverse to the longitudinal axes of the printhead segments **15** and print chips **13**.

In the printhead **1**, the printhead modules **3** are nested together via interdigitated fingers **19** longitudinally extending from opposite ends of each printhead module. In the embodiment shown, four fingers **19** at each end of one printhead module **3** correspond to the four printhead segments **15** in the printhead module, such that the total number of fingers at both ends is twice the number of printhead segments in each printhead module. As best shown in FIG. **9**, each finger **19** contains a portion of one of the printhead segments **15**, such that printhead segments of neighboring printhead modules **3** overlap across the interdigitated fingers in the printhead **1**. FIGS. **10** and **11** show the overlap region for a pair of neighboring printhead modules **3**.

Although all printhead modules are identical, in the pagewide printhead **1** according to the first embodiment each alternate printhead module (i.e. the central printhead module in FIGS. **1** and **2**) is oriented in an opposite direction with respect to a media feed direction. Referring now to FIGS. **9** and **10**, the print chip **13** contained in each finger **19** is positioned towards one lateral edge **21** of the finger. As a consequence of this offset arrangement and the alternately oriented printhead modules **3**, a distance between overlapping print chips **13** in the same color channel is minimized By minimizing the separation of corresponding printhead segments **15** in the overlap region shown in FIG. **10**, improved alignment and print quality is achieved in the overlap regions. (In the present context, "corresponding printhead segments" are printhead segments which print a same ink in a same line of print). Typically, the distance between overlapping print chips **13** from corresponding printhead segments **15** is less than 20 mm, less than 10 mm or less than 6 mm.

In order to supply power and data to the print chips **13**, the printhead module **3** according to the first embodiment has opposite first and second rigid PCBs **23** and **25** mounted parallel to each other on respective frontside and backside faces **24** and **26** of the substrate **7**. Four first PCBs **23** correspond to the four printhead segments **15**, with each first PCB being positioned alongside a respective row of print chips **13**. Each print chip **13** in one printhead segment **15** has bond pads **27** connected to its respective first PCB **23** via wirebonds (not shown). The four first PCBs **23** are connected to the second PCB **25** mounted on the backside face **26** of the substrate via electrical connectors extending through longitudinal slots **30** defined through a thickness of the substrate. In the printhead module **3** according to the first embodiment, the electrical connectors take the form of pin connectors **32** extending from each first PCB **23** engaged with complementary sockets **34** extending from the second PCB. The longitudinal slots **30** accommodating these electrical connections are alternately positioned alongside the longitudinal ink supply channels **9**, such that each pair of neighboring ink supply channels has one of the longitudinal slots positioned therebetween. As best seen in FIG. **5**, the ink supply channels **9** extend into the fingers **19** at each end of the printhead module **3** for supply of ink to the endmost print chips **13**; however, the longitudinal slots **30** accommodating the electrical connections are relatively shorter than the ink supply channels **9** and do not extend into the fingers **19**. Therefore, the print chips **13** positioned in the fingers **19** receive data and power from the pin connectors **32** routed via the first PCBs **23**, which extend into the fingers.

The alternating arrangement of longitudinal slots **30** and ink supply channels **9** simplifies routing of ink and electrical wiring through the substrate **7**. Therefore, the substrate **7** may be formed as a monolithic component. For example, the substrate **7** may be formed of a molded polymer (e.g. liquid crystal polymer), a ceramic material or a die-cast metal alloy (e.g. Invar).

As foreshadowed above, each ink supply channel **9** has a base **10** defining a plurality of ink outlets **11**, with each print chip **13** receiving ink from a set of ink outlets. As best shown in FIGS. **6** and **7**, an elongate flexible film **35** seals across a roof of each ink supply channel **9** for the purpose of dampening ink pressure fluctuations. A more detailed explanation of the form and function of the flexible film **35** can be found in U.S. Pat. No. 10,343,402, the contents of which are herein incorporated by reference.

In the printhead module **3** according to the first embodiment, the second PCB **25** covers the four elongate flexible films **35** of the four ink supply channels **9** and may be provided with vent holes (not shown) to allow flexing of the films, as required. Referring briefly to FIG. **4**, an external face of the second PCB opposite the substrate **7** has a number of electrical components **38** mounted thereon, including a power connector **39** and a data connector **40** for receiving external power and data, which are supplied to the print chips **13** via the first PCBs **23**.

Each ink supply channel **9** has a corresponding pair of ink ports **41** positioned in respective fingers **19** of the substrate **7** at opposite ends of the ink supply channel. The ink ports **41** are in the form of spouts extending away from a backside face of the printhead module **3** perpendicular to a plane of the substrate **7**. Typically, ink is recirculated through the ink supply channels **9** such that an ink port **41** at one end of the printhead module **3** is an inlet port and an ink port at an opposite end is an outlet port. The ink supply channels **9** of each printhead module **3** may be supplied with ink individually via the ink ports **41**. Alternatively, a set of printhead modules **3**, or all printhead modules in the printhead **1**, may have corresponding ink supply channels **9** serially connected via the ink ports **41**.

As shown in FIG. **12**, the ink ports **41** of neighboring printhead modules **3** are transversely aligned across the printhead and adjacent ink ports for corresponding printhead segments **15** are interconnected. In the embodiment shown, a linking manifold **43** across the printhead **1** is conveniently employed to fluidically connect corresponding aligned ink ports **41**. Other connectors (e.g. a set of individual U-pipes) may be similarly employed to provide serial fluidic connections.

Second Embodiment

Referring to FIGS. **13** and **14**, there is shown a modular inkjet printhead **100** (or "print bar") according to a second embodiment of the invention. Where relevant, like features in the first and second embodiments are identified with like reference numerals.

The printhead **100** according to the second embodiment comprises four printhead modules **103** arranged end on end and mounted on a complementary support structure, which takes the form a U-channel **105**. The U-channel has a base **106** having one or more openings configured for complementarily receiving the printhead modules **103** and, as described above, the number of printhead modules may be varied in order to construct a pagewide array of any required length.

In contrast with the printhead **1** according to the first embodiment, the printhead **100** according to the second embodiment is supplied with ink from an elongate ink carrier **101**, which take the form of a beam member extending alongside the line of printhead modules **103** and parallel with a longitudinal axis of the printhead. The ink carrier **101** is supported by a flange **107**, which extends laterally outwardly from a sidewall **109** of the U-channel **105**. Ink pipes **110** extend laterally from the ink carrier **101** towards the printhead modules **103** to connect with the ink ports **41**, while the ink carrier receives and returns ink from an ink reservoir (not shown) via ink tubes **112** connected at one end of the ink carrier. Thus, each printhead module **103** is individually supplied with and returns four colors of ink to the ink carrier **101**. The ink carrier **101** contains common ink inlet and outlet lines for each of the four colors.

Still referring to FIG. **13**, a pair of busbars **114** (power and ground) extend longitudinally along the roof of the ink carrier **101** for supplying power to the plurality of printhead modules **103**. The busbars **114** are connected to power cables **115** at a same end of the ink carrier **101** as the ink tubes **112**. With power cables **115** and ink tubes **112** extending from one longitudinal end of the printhead assembly, the footprint of the assembly is advantageously minimized in the media feed direction.

Pairs of connector straps **116** extend transversely in a horizontal plane from the busbars **114** to provide power to individual printhead modules **103**. The connector straps **116** are electrically connected to each printhead module **103** via power contacts **118** positioned on the roof of a PCB housing **119**, which houses multiple PCBs supplying power and data to the print chips **13**. The printhead modules **103** are linked via daisychained data connectors **120**, which may provide, for example, a timing signal and/or print data from a controller (not shown) to each of the printhead modules. Alternatively, the print modules **103** may receive data individually in parallel from a controller.

As shown in FIG. **15**, neighboring printhead modules **103** in the printhead **100** have interdigitated fingers **19** to provide close spacing between overlapping print chips **13** of the neighboring modules. However, in contrast with the printhead **1** according to the first embodiment, the printhead **100** according to the second embodiment has all printhead modules **103** oriented in a same direction with respect to the direction of media travel. With all printhead modules **103** similarly oriented and equal spacing of print chips in the overlap region, the data processing requirements of the printhead **100** according to the second embodiment are simplified compared to the printhead **1** according to the first embodiment.

Turning now to FIG. **16**, there is shown an individual printhead module **103** according to the second embodiment with the PCB housing **119** removed. The printhead module **103** is similar in structure to the printhead module **3** according to the first embodiment. Accordingly, each printhead module **103** according to the second embodiment comprises the substrate **7** in the form an elongate ink manifold having the four parallel ink supply channels **9** extending longitudinally along a length thereof and interspersed with longitudinal slots **30** receiving electrical connectors, which interconnect PCBs on the frontside and backside of the substrate. (see FIG. **6**).

In order to supply power and data to the print chips **13** in the printhead module **103** according to the second embodiment, five separate PCBs are mounted on the backside face **26** of the substrate **7** and extend perpendicularly with the respect to a plane of the first PCBs **23** mounted on the frontside face **24**. The rearmost PCB shown in FIG. **16** is a data PCB **122**, which receives data from a controller (not shown) via a respective data port **124**. The other four PCBs are power PCBs **126**, which are electrically connected to a respective pair of connection straps **116** via the power contacts **118** on the roof of the PCB housing **119**. The data PCB **122** distributes print data to the power PCBs **126** via, for example, ribbon connectors (not shown) and the four power PCBs are connected to respective first PCBs **23** via electrical connectors extending through the longitudinal slots **30** defined through a thickness of the substrate **7** (similar to the printhead module **3** shown in FIGS. **6** and **7** according to the first embodiment).

As shown in FIG. **13**, the four power PCBs **126** and the data PCB **122** of each printhead module **103** are contained in a respective PCB housing **119**, which may incorporate a cooling fan (not shown) to extract heat from the printhead **100**. The separation and perpendicular orientation of the power PCBs **126** assists in dissipating heat away from the substrate **7**.

FIGS. **17** and **18** show the printhead module **103** with the PCBs removed to reveal four rows of module contacts **130** on the backside face **26** of the printhead module, which connect to the four power PCBs **126**. In the printhead module **103** according to the second embodiment, the electrical connectors through the substrate **7** take the form of lead frames **132**, which are connected to the four first PCBs **23** at the frontside face **24** of the substrate. The backside face of the substrate **7** is covered with a cover plate **134**, which seals over the substrate and protects the four elongate flexible films **35** of the four ink supply channels **9**.

From the foregoing, the skilled person will readily understand that the printheads **1** and **100** are highly suitable for use in digital inkjet presses, as well as certain desktop applications, where high-speed, high quality redundant printing is desired. In particular, the minimal length of the print zone in the media feed direction, redundancy within each color plane, and excellent alignment of printhead modules within a single complementary support structure advantageously enables such printheads to be used in a range of applications.

It will, of course, be appreciated that the present invention has been described by way of example only and that modifications of detail may be made within the scope of the invention, which is defined in the accompanying claims.

The invention claimed is:

1. A modular inkjet printhead comprising a plurality of printhead modules arranged end on end in a row, each printhead module having only four rows of print chips configured for printing four different inks, each print chip having multiple nozzle rows for redundant monochrome printing of one respective ink, wherein a print zone of the printhead has a width of less than 100 mm in a media direction.

2. The modular inkjet printhead of claim **1**, wherein each print chip has at least three nozzle rows configured for redundant printing.

3. The modular inkjet printhead of claim **1**, wherein the printhead modules have at least four fingers corresponding to said four rows of print chips, the fingers of neighboring printhead modules being interdigitated.

4. The modular inkjet printhead of claim **3**, wherein each finger comprises at least a portion of a respective print chip.

5. The modular inkjet printhead of claim **4**, wherein neighboring printhead modules have overlapping print chips contained in respective fingers.

6. The modular inkjet printhead of claim **5**, wherein each finger has its respective print chip positioned towards one lateral edge thereof.

7. The modular inkjet printhead of claim **6**, wherein each alternate printhead module is oppositely oriented with respect to a media feed direction, thereby positioning overlapped print chips in relative proximity to each other.

8. The modular inkjet printhead of claim **3**, wherein the fingers extend from opposite ends of a respective printhead module.

9. The modular inkjet printhead of claim **1**, wherein each printhead module is oriented in a same direction with respect to a media feed direction.

10. The modular inkjet printhead of claim **1**, wherein each print chip receives power and data through a respective longitudinal slot.

11. The modular inkjet printhead of claim **10**, wherein the monolithic substrate is comprised of a material selected from: polymers, metal alloys and ceramics.

12. The modular inkjet printhead of claim **1**, wherein the longitudinal slots are alternately arranged with longitudinal ink supply channels in each printhead module.

13. The modular inkjet printhead of claim **12**, wherein each printhead module comprises a monolithic substrate having the longitudinal ink supply channels and longitudinal slots defined therein.

14. The modular inkjet printhead of claim **12**, wherein each monolithic substrate has opposite first and second faces, the first face having one or more first PCBs mounted thereon and the second face having one or more second PCBs mounted thereon.

15. The modular inkjet printhead of claim **14**, wherein the first and second PCBs are generally perpendicular to each other.

16. The modular inkjet printhead of claim **14**, wherein the first and second PCBs are connected via electrical connectors extending through longitudinal slots defined in the substrate.

17. The modular inkjet printhead of claim **14** comprising a plurality of first PCBs co-mounted on the first face of each printhead module with the print chips, each row of print chips being electrically connected to a respective first PCB.

18. The modular inkjet printhead of claim **17**, wherein each print chip is electrically connected to its respective first PCB via wirebonds.

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